

Objective Outcomes Following Semi-Constrained Total Distal Radioulnar Joint Arthroplasty

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Abstract

A dysfunctional distal radioulnar joint (DRUJ) can significantly compromise an individual's forearm rotation, grip, and weight bearing at the hand and wrist. This retrospective study reports surgeon- and therapist-collected objective wrist function and subjective pain scores of 10 patients who received the Scheker total DRUJ prosthesis. A review of these patients' medical records was performed to collect preoperative measurements of wrist range of motion (ROM), grip strength, and pain scores (0–10 scale). The degree of pronation, supination, flexion, extension, radial deviation, and ulnar deviation were the outcome measures used to evaluate wrist ROM. Postoperative measurements were collected at a follow up of 5 ± 1.1 years in our clinic (minimum follow-up of 2yrs). Mean final wrist flexion and extension were $32.1 \pm 22.8^\circ$ and $44.8 \pm 13.9^\circ$, respectively. Mean final supination and pronation were $72.5 \pm 14.4^\circ$ and $69.5 \pm 14.6^\circ$, respectively. Average grip strength was 54.9 ± 23.7 lbs. The mean pain score was 3.6 ± 3.1 . Although there were no statistically significant changes in any of these outcome measures, the Scheker prosthesis improved wrist ROM (with the exception of wrist flexion) and decreased pain. Grip strength decreased by less than 1 lb but was still higher than the postoperative grip strength measurements in the literature for this prosthesis. Because of the self-stabilizing nature of this prosthesis and the satisfactory functional outcomes from this study and other studies, the Scheker prosthesis is still a viable option for DRUJ pathology that is refractory to nonimplant arthroplasties. This is a therapeutic level IV study.

Keywords

- distal radioulnar joint
- arthroplasty
- wrist
- Scheker prosthesis

Posttraumatic degenerative joint disease or arthritis of the distal radioulnar joint (DRUJ) diminishes grip strength, lifting capacity, and wrist range of motion (ROM), particularly in supination and pronation.^{1,2} Traditionally, partial and complete resections of the distal ulna were employed to treat a painful and dysfunctional DRUJ. Impingement of the ulnar remnant on the radius was a painful complication of these resections, especially in active patients.^{3–5} Ulnar head implants were also developed to replace the resected ulna. They have improved ROM, grip strength, and reduced pain. However, these hemiarthroplasties require an intact radial

sigmoid notch as well as a stable DRUJ or a reconstructable triangular fibrocartilage.^{6–9}

The Aptis constrained DRUJ prosthesis (APTIS Medical, Louisville, Kentucky, USA) was created by Dr. Luis Scheker to address these complications and was cleared by the FDA in 2005; thus, it is also known as the Scheker prosthesis. Its self-stabilizing design enables it to functionally replace the ulnar head, the sigmoid notch, and the DRUJ ligaments. It consists of an endomedullary ulnar stem and an ultrahigh-molecular-weight (UHMW) polyethylene ball that fits into a socket on a plate that is fixed to the radius.^{10–12} This prosthesis is

indicated in skeletally mature patients who have had traumatic, rheumatoid, or degenerative arthritis of the DRUJ, especially if it is accompanied by instability or a compromised sigmoid notch. It is strongly indicated in those with unsuccessful Darrach, Sauvé-Kapandji, or other resection arthroplasties as well as those with unstable and painful ulnar head implants. It is also indicated in patients with congenital DRUJ pathology, such as Madelung deformity, or those who have undergone distal ulnar resection to remove a tumor. The contraindications include a proximal ulna measuring less than 11 cm; titanium or nickel allergies; severe osteoporosis; or an active infection.¹¹ The purpose of this study is to evaluate the implant's effect on wrist ROM, grip strength, and level of pain for 10 patients.

Patients and Methods

A retrospective chart review was conducted for patients that underwent implantation of the Scheker total DRUJ prosthesis from 2005 to 2010. One patient was excluded for removal of the prosthesis shortly after implantation due to infection. Another patient was excluded for concurrent implantation of the Scheker prosthesis and the UNI 2 total wrist implant (Integra, Plainsboro, New Jersey, USA); the total wrist implant

was considered a confounder in assessing the efficacy of the Scheker implant. Eight patients with less than 2 years of follow-up and/or incomplete datasets were excluded. After these exclusion criteria, there was a total of 10 patients for this study: five men and five women. The mean age was 56.2 ± 16.1 years. Seven patients had posttraumatic DRUJ disease, one patient had DRUJ osteoarthritis, one patient had Madelung deformity, and another had cancerous destruction of the distal ulna (**►Fig. 1a–d**). Posttraumatic DRUJ disease was a distal radius fracture, a distal ulnar fracture, or traumatic DRUJ instability that led to arthritis. The average time from injury or presentation for DRUJ osteoarthritis to Scheker prosthesis implantation was 30.3 months (range, 4.4–44.2 months). Four patients had an unsuccessful ulnar resection or ulnar head implant prior to receiving the Scheker prosthesis (**►Fig. 1a–d**). The mean time from surgery to final follow up was 5 years (range, 2.8–6 years).

The following demographic data were collected from the medical records of all patients: age; sex; diagnosis; dates of operations and follow-ups; specifics of operations; complications; preoperative and postoperative wrist ROM measurements including pronation, supination, flexion, extension,



Fig. 1 (a, b) Preoperative posteroanterior (PA) and lateral X-ray views showing posttraumatic DRUJ arthritis with a hemiarthroplasty. (c, d) PA and lateral views 2 years after implantation of a total DRUJ arthroplasty.



Fig. 2 (a) Preoperative PA view of a wrist with metastatic melanoma of the distal ulna. (b) Preoperative MRI showing the tumor. (c, d) PA and lateral views of the forearm 2 years postoperatively after total DRUJ arthroplasty.

radial deviation, and ulnar deviation; grip strength; and Visual Analog Scale (VAS) pain scores (0–10 scale).

All 10 patients were brought into clinic for final follow-up. The degree of pronation, supination, flexion, extension, radial deviation, and ulnar deviation were measured according to the American Medical Association (AMA) standards in the Guides of the Evaluation of Permanent Impairment.¹³ In line with the AMA standards, a goniometer was used for these measurements. Grip strength was also measured using these AMA standards with a dynamometer. A two-tailed, paired *t*-test for independent samples assuming unequal variance was performed to compare preoperative to postoperative outcome measures. A *P* value < 0.05 denotes statistical significance.

Operative Technique

The Scheker prosthesis is a self-stabilizing spheroidal joint composed of a radial and an ulnar component that are both made of made of 316 medical grade stainless steel(. Implantation of this prosthesis has been described previously.¹¹ First, an incision is made on the dorsoulnar aspect of the distal forearm, radial to the extensor carpi ulnaris (ECU) tendon. The ulna is mobilized from the radius and freed from the surrounding tissue. A template is placed at the sigmoid notch on the long axis of the radius. Resection of the distal ulna allows access to the ulnar aspect of the distal radius. A 2-cm gap is created between the ulna and the distal articulating surface of the radius to make room for the radial side plate, the flare of the ulnar stem, and the socket of the prosthesis. The template guide is fixed to the radius through the middle screw hole. A 2-cm long transverse tunnel in the distal radius is created. The peg at the distal end of the radial plate is then inserted into this tunnel. The middle screw and the adjacent screws are then secured. The fluted end of the stem is press-fitted into the medullary cavity of the ulna. The polyethylene ball is placed on the peg of the stem when the flare of the stem is 5 mm past the proximal border of the socket. Once the ball is in the socket, the ulnar portion of the radial plate cover is secured with two small screws. The range of pronation and supination is examined for stability and limitations in motion. The interosseous membrane should be divided partially until satisfactory motion is achieved. To

ensure appropriate soft tissue healing after wound closure, a well-padded sugar tong splint is applied for 2 weeks. Afterwards, the patient may start active ROM and hand therapy.

Results

Mean preoperative wrist ROM measurements, grip strength, and pain scores were collected from medical records and compared with the postoperative measurements from final follow up at 5 ± 1.1 years in our clinic [► **Table 1**]. Mean wrist flexion decreased postoperatively from $45 \pm 21.4^\circ$ ($n = 7$) to $32.1 \pm 22.8^\circ$ ($n = 10$), while extension increased from $35 \pm 14.6^\circ$ ($n = 7$) to $44.8 \pm 13.9^\circ$ ($n = 10$). Mean supination increased from $63.6 \pm 16.6^\circ$ ($n = 7$) to $72.5 \pm 14.4^\circ$ ($n = 10$). Pronation increased from $64.3 \pm 21.3^\circ$ ($n = 7$) to $69.5 \pm 14.6^\circ$ ($n = 10$). Average ulnar deviation increased from $21.7 \pm 11.4^\circ$ ($n = 6$) to $25.3 \pm 5.4^\circ$ ($n = 10$), while radial deviation increased from $10.8 \pm 5.3^\circ$ ($n = 6$) to $13 \pm 8.8^\circ$ ($n = 10$). Average grip strength decreased slightly from 55.5 ± 25.6 lbs ($n = 3$) to 54.9 ± 23.7 lbs ($n = 10$) postoperatively. The average VAS pain score decreased from 4.8 ± 2 ($n = 6$) to 3.6 ± 3.1 ($n = 10$). None of these changes in these outcome measures was statistically significant. In general, there was an increase in ROM, with the exception of wrist flexion, while pain decreased. Grip strength measurements were nearly identical preoperatively and postoperatively.

Discussion

Traditional partial and complete resections of the distal ulna have not been routinely satisfactory in treating painful and dysfunctional DRUJ problems.⁵ Hemiarthroplasties such as ulnar head implants have produced reasonable outcomes in retrospective reviews but require an intact radial sigmoid notch as well as ligamentous support to stabilize the DRUJ.^{7,9} The Scheker prosthesis functionally replaces the ulnar head, the sigmoid notch, and the ligaments and is ideal for the unstable DRUJ with or without sigmoid notch destruction.

Our patient cohort demonstrated a postoperative improvement in pain scores and ROM with the exception of

Table 1 Preoperative to postoperative comparison of outcome measures (5 ± 1.1 years follow-up)

Outcome measure	Average preoperative measurement	Average postoperative measurement	<i>P</i> value
Wrist flexion ($^\circ$)	45 ± 21.4 , $n = 7$	32.1 ± 22.8 , $n = 10$.29
Wrist extension ($^\circ$)	35 ± 14.6 , $n = 7$	44.8 ± 13.9 , $n = 10$.22
Supination ($^\circ$)	63.6 ± 16.6 , $n = 7$	72.5 ± 14.4 , $n = 10$.30
Pronation ($^\circ$)	64.3 ± 21.3 , $n = 7$	69.5 ± 14.6 , $n = 10$.61
Ulnar deviation ($^\circ$)	21.7 ± 11.4 , $n = 6$	25.3 ± 5.4 , $n = 10$.53
Radial Deviation ($^\circ$)	10.8 ± 5.3 , $n = 6$	13 ± 8.8 , $n = 10$.58
Grip Strength (lb)	55.5 ± 25.6 , $n = 3$	54.9 ± 23.7 , $n = 10$.98
Pain (0–10 scale)	4.75 ± 2 , $n = 6$	3.6 ± 3.1 , $n = 10$.40

wrist flexion. The average wrist flexion of $32.1 \pm 22.8^\circ$ in our study was skewed by one patient who developed an extension contracture of the wrist postoperatively secondary to concomitant extensor tendon repairs. Grip strength decreased by less than a pound. However, none of these changes was statistically significant.

There are three studies on the Scheker prosthesis: one by Zimmerman and Jupiter, one by Axelsson and Sollerman, and one by Scheker et al.^{14–16} At an average follow up of 2.4 ± 0.7 years, Zimmerman and Jupiter reported that six patients had mean postoperative $80 \pm 8.9^\circ$ supination (range, $60–90^\circ$) and $86.7 \pm 5.2^\circ$ pronation (range, $80–90^\circ$). These final measurements are higher than the $72.5 \pm 14.4^\circ$ supination and $69.5 \pm 14.6^\circ$ pronation that we reported at 5 ± 1.1 years postoperatively. They reported only postoperative wrist ROM measurements, which makes it difficult to elucidate the effect of this prosthesis on these outcome measures. Scheker et al reported an increase in supination postoperatively from $52 \pm 29.1^\circ$ ($n = 16$) to $75 \pm 17.9^\circ$ ($n = 20$) and increase in pronation from $66 \pm 30.6^\circ$ ($n = 15$) to $81 \pm 11.2^\circ$ ($n = 20$) at a follow up of 5 years for 35 patients. Both of these improvements were statistically significant ($p < .05$). Our cohort had higher mean grip strength of 54.9 ± 23.7 lbs than the mean grip strength of 48.6 ± 35.8 lbs reported by Zimmerman and Jupiter. Scheker's cohort demonstrated a statistically significant increase in preserved grip strength (% contralateral side) from 48% (SD 29.5, $n = 13$) to 90% (SD 57.1, $n = 22$) postoperatively, while our cohort's mean grip strength decreased slightly from 55.5 ± 25.6 lbs ($n = 3$) to 54.9 ± 23.7 lbs ($n = 10$). At an average follow up of 3.7 years (range, 2–5), Axelsson and Sollerman reported that nine patients had a 25% median increase in their grip strength ($P = .09$). Although these studies used different grip strength outcome measures, they demonstrate that most patients' grip strength remained relatively the same or increased postoperatively.

The mean VAS pain score (0–10 scale) in our cohort decreased from 4.8 ± 2 ($n = 6$) to 3.6 ± 3.1 ($n = 10$). In Scheker et al's cohort, pain with activity significantly decreased from 8.25 (SD 1.2, $n = 8$) to 2.71 (SD 2.7, $n = 24$) after surgery ($P < .05$). Only two of the six patients in Zimmerman and Jupiter's study reported pain postoperatively. Axelsson and Sollerman's cohort had a median postoperative VAS score of 0.3 versus a preoperative VAS score of 6 ($P = .01$). Overall, pain decreased with this prosthesis.^{14–16}

Other than the Scheker prosthesis, the only other available total DRUJ prosthesis is the Stability Sigmoid Notch Total DRUJ system (Small Bone Innovations, Morrisville, Pennsylvania, USA). The Stability prosthesis consists of the U-Head ulnar head prosthesis and a polyethylene sigmoid notch resurfacing implant. At a follow up of 46 months, Ewald and Moran report that a cohort of 4 patients had a final mean of 80 (range, $60–90^\circ$) pronation and 64 (range, $45–90^\circ$) supination. Grip strength increased from 16.53 lbs preoperatively to 56.22 lbs postoperatively, while pain scores decreased from 8 to 2.5. These mean postoperative outcome measures are comparable to those from the aforementioned studies on the Scheker prosthesis. However, this prosthesis requires capsular and soft tissue stability for

good outcomes because it is not constrained like the Scheker prosthesis.¹⁷

This study is limited by the small sample size and its retrospective nature. There is no control group, which introduces bias, and there is no power analysis. However, this total joint prosthesis is promising because of its self-stabilizing design, alleviating the need for an intact sigmoid notch or intact ligamentous support. Four of the 10 patients had one prior unsuccessful ulnar resection or replacement before implantation of the Scheker prosthesis, which further highlights its utility in situations where traditional arthroplasties or other implants have failed. The other six study subjects had either distal ulna arthritis with instability or DRUJ arthritis with a dysfunctional sigmoid notch. These are strong indications for Scheker implantation. The length of implant survivorship is still unknown, but Scheker's cohort had a 100% 5-year implant survival rate, while only one of the 20 patients who have received the Scheker prosthesis at our institution has had it removed (for infection).¹⁴

The revision options for a failed Scheker prosthesis are unknown and will require further study. It is clear that this prosthesis has produced satisfactory postoperative ROM, pain score, and grip strength outcomes. Our study along with previous studies demonstrates that this prosthesis is a suitable solution for patients with dysfunctional distal radioulnar joints as well as those who have not responded to other arthroplasties. Based on the experience gained from this cohort of patients, it is our preference to use this prosthesis when there are no other reasonable alternatives to treat severe DRUJ arthritis.

Conflict of Interest
None

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